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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention irradiates an X-ray at a sample, and relates to the X-ray plant which detects the X-ray diffracted or reflected by the sample.
[0002]
[Description of the Prior Art] The X-ray plant using the so-called wide angle goniometer as an X-ray plant which makes a powder sample the measuring object is known. In this X-ray plant, as shown in drawing 4 , the emission regulation slit 51 restricts the X-ray emitted from the X line source F, and incidence is carried out to Sample S. By rotating the sample axis omega for Sample S as a core, or rotating the sample axis omega for the X line source F as a core, theta is changed continuously or intermittently whenever [incident angle / of the X-ray about Sample S]. And it is made to synchronize with change of theta whenever [incident angle], X-ray detector 52 and the light-receiving slit 53 are rotated with angular velocity twice the angular velocity of theta whenever [incident angle] focusing on the sample axis omega, and X-ray detection include-angle 2theta of X-ray detector 52 to the optical axis L of an incidence X-ray is changed continuously or intermittently.
[0003] The distance R1 from the X line source F to Sample S and the distance R2 of a before [from Sample S / the light-receiving slit 53] are set up equally, and therefore, when whenever [X-ray incident angle / theta], and X-ray detection include-angle 2theta change, the X line source F, Sample S, and the light-receiving slit 53 are located on the circle from which a path changes corresponding to include-angle change of them theta and 2theta. Generally this circle is called the concentration circle.
[0004] If Bragg's diffraction conditions are satisfied between an incidence X-ray and the crystal plane of Sample S when theta changes whenever [over Sample S / X-ray angle-of-incidence], an X-ray will diffract by the sample S. The diffracted X-ray condenses to the light-receiving slit 53 on the concentration circle C, and passes this slit, and is incorporated by X-ray detector 52. In this way, the include angle which an X-ray diffracts about Sample S, i.e., X diffraction angle 2theta, and its diffracted reinforcement of an X-ray are measured, and various analyses are performed about Sample S based on the measurement result.
[0005] moreover , the so-called small angle scattering measurement which observe [whenever / about / 2theta=0-3 degree / corniculus] the situation of change of the reinforcement of the scattered X-rays in a field whenever [center on optical axis of incidence X-ray angle of diffraction] be also know in order to observe structure observation of a body , the magnitude of a particulate matter , and a configuration with long period structures , such as structure of a fibrous biopolymer etc. , and an array condition of the microcrystal in a macromolecule solid-state . From before, equipment using 3 slit system X-ray optics system as an X-ray plant for performing such small-angle-scattering measurement is known, and it is.
[0006] In this small angle scattering goniometer, as shown in drawing 5 , an parallel X-ray beam is taken out from the X-ray emitted from the X line source F using two slits, the 1st slit 55 and the 2nd slit 56, and that parallel X-ray beam is irradiated at Sample S. It prevents that the scattered X-rays generated to the 2nd slit 56 carry out incidence of the 3rd slit 57 to Sample S.

[0007] If an parallel X-ray beam carries out incidence to Sample S, scattered X-rays occur according to the internal structure of the sample, and the scattered X-rays will reach 2-dimensional X-ray detectors 58, such as an X-ray film, and will expose it. It may replace with 2-dimensional X-ray detector 58, a single dimension X-ray detector may be moved in the direction of X diffraction include-angle 2theta centering on the core 0 of Sample S, and scattered X-rays may be detected.
[0008] Since the X-ray plant shown in drawing 5 carries out incidence of the parallel X-ray beam to Sample S, it may be called a collimated beam system X-ray plant. And in this collimated beam system X-ray plant, although the above small-angle-scattering measurement is performed, what performs thin film measurement and other various measurement is contained elsewhere. Thin film measurement makes the measuring object the sample of the shape of film with thin thickness, and it carries out incidence of the parallel X-ray beam with narrow width of face to that thin film sample by this measuring method by whenever [low incident angle], for example, whenever [about 2-degree incident angle].
[0009]
[Problem(s) to be Solved by the Invention] In the conventional X-ray plant, the equipment of the concentration optical system shown in drawing 4 and the equipment of a collimated beam system as shown in drawing 5 were prepared as a respectively separate dedicated device. That is, when the optical element of concentration optical system is arranged to X line source, and an X-ray plant is constituted, when performing the concentrating method X-ray measurement, and performing parallel beam method X-ray measurement, the optical element of a collimated beam system is arranged to X line source, and an X-ray plant is constituted. However, it was very troublesome to rearrange an X-ray optics element, whenever it changes a measuring method. Since optical-axis adjustment had to be performed about each optical element whenever it attached a new optical element especially, it was very troublesome. This invention aims at offering the X-ray plant which can perform both measurement of the concentrating method X-ray measurement and parallel beam method X-ray measurement, without being made in view of the above-mentioned trouble, and changing the arrangement location of an X-ray optics element.
[0010]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the X-ray plant concerning this invention In the X-ray plant which has 3 slit system X-ray optics system which is arranged in X linear-light on the street between X line source and a sample, and contains three slits, and an X-ray detection means to detect the X-ray which comes out of a sample The goniometer which carries out the measurement of angle of the angle of rotation centering on a sample axis about a sample and an X-ray detection means, While having the 5th slit which is laid on the goniometer and arranged in front of an X-ray detection means, and the 4th slit which is laid on the above-mentioned goniometer and arranged in front of the 5th slit of the above It is characterized by the three above-mentioned slits, the 4th slit, and the 5th slit setting up equally the distance from X line source further to [can change the slit width and] a sample, and the distance from a sample to the 5th slit.
[0011] that which obtains the slit width of each slit as modification is possible The approach of equipping the slit supporter material which prepares two or more kinds of slits from which slit width differs, chose one from from among those slits, and was installed in the predetermined location X linear-light on the street, It is attained by the approach of equipping slit supporter material X linear-light on the street with the slit equipped with the function in which the magnitude of slit width can be adjusted, and adjusting the slit width of the slit if needed etc.
[0012] Since according to the X-ray plant of this invention it saw from the sample and 3 slit system X-ray optics system was prepared in X line source side, it can perform taking out the X-ray which came out of X line source as a collimated beam, and irradiating a sample, i.e., parallel beam method X-ray measurement. Furthermore, since the sample and the X-ray detection means were carried in the goniometer while setting up equally the distance between X line source and a sample, and the distance between a sample and the 5th slit, the concentrating method X-ray measurement can also be performed.
[0013] When performing the concentrating method X-ray measurement in this X-ray plant, it is enough if one slit which works as an emission regulation slit is arranged at X line source side of a sample.

Therefore, two slits other than the slit which works as an emission regulation slit among 3 slit system X-ray optics systems installed in X line source side of a sample are set as the condition of not participating in regulation of an X-ray beam. And the slit itself is removed from slit supporter material, and if it is a slit with a slit width accommodation function, specifically, slit width will be opened [it will change into the so-called opening condition, or] greatly. [substituting those slits for another slit with big slit width]

[0014]
[Embodiment of the Invention] Drawing 1 shows 1 operation gestalt of the X-ray plant concerning this invention. This X-ray plant has the goniometer 4 which supports Sample S, and the detector arm 9 extended from that goniometer. Single dimension X-ray detector 2 which can detect an X-ray in a narrow punctiform field is carried at the tip of the detector arm 9. Moreover, between Sample S and the X line source F, 3 slit system X-ray optics system 11 which has the 1st slit 5, the 2nd slit 6, and the 3rd slit 7 is arranged.
[0015] Slit supporter material 6a and slit supporter material 7a are equipped with the 2nd slit 6 and the 3rd slit 7 removable, respectively. on the other hand -- the 1st slit 5 -- slit supporter material 5a -- the direction of arrow-head A-B -- closing motion -- it is supported movable. It connects with the slit width adjustment 12 which makes a motor etc. the source of power, and closing motion migration of the 1st slit 5 is driven and carried out with the slit width adjustment 12. Moreover, it connects with the slit centering-control equipment 13 which makes a motor etc. the source of power, and slit supporter material 5a is driven with the slit centering-control equipment 13, and carries out both-way migration in the direction of a right angle substantially to X linear-light way like an arrow head C. That it is substantial here is semantics included also when shifting [strict] from a right angle according to a manufacture error, an assembly error, etc.
[0016] A well-known both-way drive can be used for the slit width adjustment 12 and slit centering-control equipment 13 from before. However, since these adjustments must adjust a slit location with a delicate dimension, it is desirable to be constituted including the fine adjustment device in which it is used by a micrometer etc.
[0017] Twotheta rotation drive system 15 for doing 2theta rotations of theta rotation drive system 14 and the detector arm 9 for doing theta rotation of Sample S a core [the sample axis omega] a core [the sample axis omega] is attached, and is installed in a goniometer 4. Here, theta rotation is rotating Sample S continuously or intermittently with a predetermined angular velocity focusing on the sample axis omega in order to change whenever [incident angle / of the X-ray to Sample S]. Moreover, 2theta rotations are rotating X-ray detector 2 in the same direction by rotation twice the angular velocity of theta focusing on the sample axis omega, in order to detect the X-ray diffracted by 2theta whenever [proper angle-of-diffraction] in the place of Sample S. In addition, each rotation drive systems 14 and 15 can do 2theta rotations only of X-ray detector 2, where it could operate uniquely, respectively, therefore Sample S is held to a quiescent state.
[0018] The slit supporter material 18 is arranged on the detector arm 9 ahead of X-ray detector 2 (left of drawing), and another slit supporter material 17 is further arranged on the detector arm 9 ahead of the slit supporter material 18. The slit supporter material 17 is equipped with the 4th slit 19 removable, and the slit supporter material 18 is equipped with the 5th slit 21 removable. In addition, the X line source F, the distance R1 between Samples S, and the distance R2 between Sample S and the 5th slit 21 are set up equally mutually.
[0019] The X-ray plant which consists of the above-mentioned configuration can choose and perform either the concentrating method X-ray measurement and parallel beam method X-ray measurement by changing optical arrangement of each slit. Hereafter, each is explained.
(Small-angle-scattering measurement) Drawing 1 shows the optical arrangement at the time of performing small-angle-scattering measurement which is an example of parallel beam method X-ray measurement. In this small-angle-scattering measurement, the slit of the same slit width is used for the 1st slit 5 and the 2nd slit 6, and a slit with slightly wide slit width is further used rather than the 2nd slit 6 as the 3rd slit 7. Furthermore, it equips with the narrow light-receiving slit RS of slit width as the 4th

slit 19 on the detector arm 9, and equips with the large dispersion prevention slit SS of slit width as the 5th slit 21. here, slit width is narrow -- it is -- it is -- it is relatively narrow between these two slits 19 and 21 to have said that it is large -- it is -- it is -- it is and narrow [I hear that it is large, and] in absolute semantics -- it is -- it is -- it is large -- ********** -- there is nothing.

[0020] Under the above conditions, while emitting an X-ray from the X line source F, revolution migration of the detector arm 9 is carried out [whenever / corniculus] in a field whenever [field, for example, about / 2theta=2 degree / corniculus,]. The X-ray emitted from the X line source F is taken out by the 1st slit 5 and the 2nd slit 6 as an parallel X-ray beam, and the parallel X-ray beam carries out incidence to Sample S by them. Then, corresponding to the internal crystal structure of Sample S, scattered X-rays occur in a field whenever [corniculus], and it is detected by X-ray detector 2 of which 2theta rotation is done after the scattered X-rays pass the 4th slit 19 (light-receiving slit RS). It prevents that the scattered X-rays generated to the 2nd slit 6 carry out incidence of the 3rd slit 7 arranged during the above measurement and at X line source side of Sample S to Sample S. Moreover, the 5th slit 21 (dispersion prevention slit SS) prepared on the X-ray detector arm 9 prevents that the scattered X-rays generated to the 4th slit 19 (light-receiving slit RS) are detected by X-ray detector 2.

[0021] With this operation gestalt, by adjusting the slit width of the 1st slit 5 with the slit width adjustment 12, and adjusting the location of slit supporter material 5a in the direction of a right angle substantially to an X-ray beam to coincidence with slit centering-control equipment 13, the parallel precision between the 1st slit 5 and the 2nd slit 6 can be set up strictly, and, thereby, an parallel X-ray beam with strong reinforcement can be taken out.

[0022] (Measurement of a powder sample) Drawing 2 shows the optical arrangement at the time of performing X diffraction measurement to the powder sample which is an example of the concentrating method X-ray measurement. This measurement is performed by adding the following modification to the optical arrangement shown in drawing 1 . First, a powder sample S is stuffed into a sample holder, and it equips with the sample holder on a goniometer 4. And the 1st slit 5 in 1st slit supporter material 5a is changed into an opening condition. The 1st slit 5 is removed from slit supporter material 5a, or, specifically, the 1st slit 5 is greatly opened to extent which does not regulate an X-ray beam.

[0023] Furthermore, the 4th slit 19 and the 5th slit 21 on the detector arm 9 are replaced. That is, the 4th slit 19 is equipped with the large dispersion prevention slit SS of width of face, and the 5th slit 21 is equipped with the narrow light-receiving slit RS of width of face. With this operation gestalt, since the distance R1 from the X line source F to Sample S and the distance R2 from Sample S to the 5th slit 21 are set up equally, the X line source F, Sample S, and the 5th slit 21 are always located on the concentration circle C.

[0024] While emitting an X-ray from the X line source F, theta rotation of Sample S is done a core [the sample axis omega], and coincidence is made to do 2theta rotations of X-ray detector 2 a core [the sample axis omega] under the above conditions. The X-ray beam by which the emission was regulated by the 2nd slit 6 which the X-ray emitted from the X line source F commits as an emission regulation slit, and emission was regulated is irradiated by Sample S. At this time, the 3rd slit 7 prevents that the scattered X-rays generated to the 2nd slit 6 go to a sample 2, prevents by this that a noise component brings a result of X diffraction measurement large, and improves a S/N ratio. The slit width of the 3rd slit 7 is adjusted by the magnitude for which it was suitable although advance of scattered X-rays could be prevented if needed.

[0025] If satisfied with the crystal plane of the sample S of which theta rotation is done, and it between the X-rays which carry out incidence of Bragg's diffraction conditions, the diffraction of an X-ray arises by Sample S, the diffraction X-ray will converge on the 5th slit 21 (light-receiving slit RS), and this slit will be passed, and it will be detected by X-ray detector 2. At this time, scattered X-rays with the 4th excessive slit 19 (dispersion prevention slit SS) prevent going into X-ray detector 2. The reinforcement of angle-of-diffraction [which a diffraction X-ray generates] whenever 2theta, and its diffraction X-ray is measured about Sample S by the above, and the qualitative analysis or quantitative analysis of a powder sample S is carried out based on the measurement result.

[0026] (Thin film measurement) Drawing 3 shows the optical arrangement at the time of performing

thin film measurement which is an example of parallel beam method X-ray measurement. This measurement is performed by adding the following modification to the optical arrangement shown in drawing 1 . First, it equips with the semi-conductor wafer with which the laminating of the thin film sample S, for example, the metal thin film, was carried out on a goniometer 4. And the 1st slit 5 in 1st slit supporter material 5a and the 2nd slit 6 in 2nd slit supporter material 6a are set as equal slit width mutually [it is narrow and].

[0027] In this condition, if an X-ray is emitted from the X line source F, an parallel X-ray beam with narrow width of face will be taken out by the work by the 1st slit 5 and the 2nd slit 6, and that parallel X-ray beam will carry out incidence to the thin film sample S by it from a direction with a low include angle [alpha] of 0.1 degrees - about 5 degrees. The detector arm 9 is made intermittent 2theta rotations at intervals of a predetermined include angle a core [the sample axis omega], carries out a predetermined time halt in each angular position, and measures the diffraction X-ray from Sample S. Also when the thickness of Sample S is very thin, the large surface field of Sample S can be made to carry out incidence of the equal X-ray of whenever [incident angle] by carrying out incidence of the parallel X-ray beam from low include-angle alpha to Sample S. Therefore, in case the diffraction of an X-ray arises by Sample S as a result, a powerful strong diffraction X-ray can be taken out and it can lead to X-ray detector 2.

[0028] (Conclusion) Although some measurement gestalten above desirable as a measurement gestalt using the X-ray plant concerning this invention were mentioned, in addition to this, the X-ray plant of this invention can be adapted for various X-ray measurement. For example, considering parallel beam method measurement, the X-ray plant of this invention is applicable also about measurement of the pole, measurement of residual stress, etc. in addition to the above-mentioned small-angle-scattering measurement and thin film measurement.

[0029]

[Effect of the Invention] According to the X-ray plant according to claim 1, without changing the arrangement location of optical elements, such as a slit, according to hope, both measurement of the concentrating method X-ray measurement and parallel beam method X-ray measurement can be chosen freely, and can be performed. And if optical-axis adjustment of the optical system of an X-ray plant is performed first, in case a measuring method will be changed between the concentrating method X-ray measurement and parallel beam method X-ray measurement, it becomes unnecessary to perform optical-axis adjustment of an X-ray optics system each time, and operability improves remarkably.

[0030] According to the X-ray plant according to claim 2, in case parallel beam method X-ray measurement is performed, an parallel X-ray beam with strong reinforcement can be taken out by accommodation of slit width.

[0031] According to the X-ray plant according to claim 3, in case parallel beam method X-ray measurement is performed, an parallel X-ray beam with strong reinforcement can be taken out by accommodation of a slit location. If it is made to perform accommodation of slit width, and accommodation of a slit location to coincidence especially, it will become possible to take out an parallel X-ray beam with still stronger reinforcement.

[0032]

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CLAIMS

[Claim(s)]
[Claim 1] In the X-ray plant which has 3 slit system X-ray optics system which is arranged in X linear-light on the street between X line source and a sample, and contains three slits, and an X-ray detection means to detect the X-ray which comes out of a sample The goniometer which carries out the measurement of angle of the angle of rotation centering on a sample axis about a sample and an X-ray detection means, The 5th slit which is laid on the goniometer and arranged in front of an X-ray detection means, It has the 4th slit which is laid on the above-mentioned goniometer and arranged in front of the 5th slit of the above. And the three above-mentioned slits, the 4th slit, and the 5th slit are an X-ray plant characterized by to have been able to change those slit width and setting up equally the distance between X line source and a sample, and the distance between a sample and the 5th slit further.
[Claim 2] The X-ray plant characterized by establishing the slit width accommodation means for adjusting the slit width of the 1st slit nearest to X line source of the three slits which constitute 3 slit system X-ray optics system in an X-ray plant according to claim 1.
[Claim 3] The X-ray plant characterized by establishing a slit centering-control means to adjust the location of the 1st slit nearest to X line source of the three slits which constitute 3 slit system X-ray optics system in a longitudinal direction to X linear-light way in an X-ray plant according to claim 1 or 2.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the front view showing the situation in the case of performing small-angle-scattering measurement which is one of the parallel beam method X-ray measurement using an example of the X-ray plant concerning this invention.
[Drawing 2] It is the front view showing the situation in the case of performing the concentrating method X-ray measurement to a powder sample using the X-ray plant of drawing 1 .
[Drawing 3] It is the front view showing the situation in the case of performing thin film measurement which is one of the parallel beam method X-ray measurement using the X-ray plant of drawing 1 .
[Drawing 4] It is a top view for explaining the general measuring method by the concentrating method X-ray measurement.
[Drawing 5] It is a top view for explaining the small-angle-scattering measurement which is an example of parallel beam method X-ray measurement.
[Description of Notations]
2 X-ray Detector
4 Goniometer
5 1st Slit
6 2nd Slit
7 3rd Slit
5a, 6a, 7a Slit supporter material
11 3 Slit System X-ray Optics System
17 18 Slit supporter material
19 4th Slit
21 5th Slit
C Concentration circle
F X line source
R1 Distance between X line source-samples
R2 Distance between the sample-5th slit
RS Light-receiving slit
SS Dispersion prevention slit
S Sample
omega Sample axis

[Translation done.]

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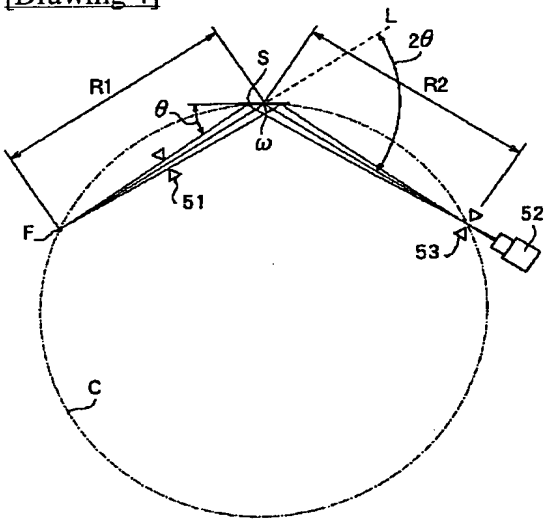
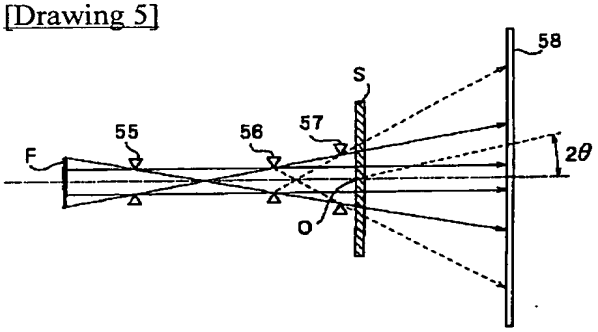
DRAWINGS

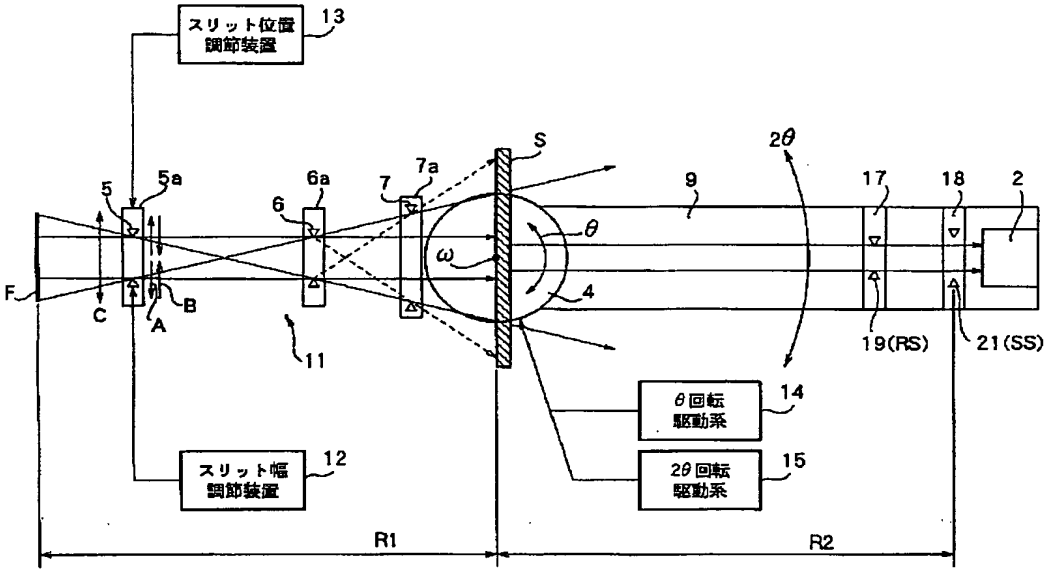
[Drawing 4]



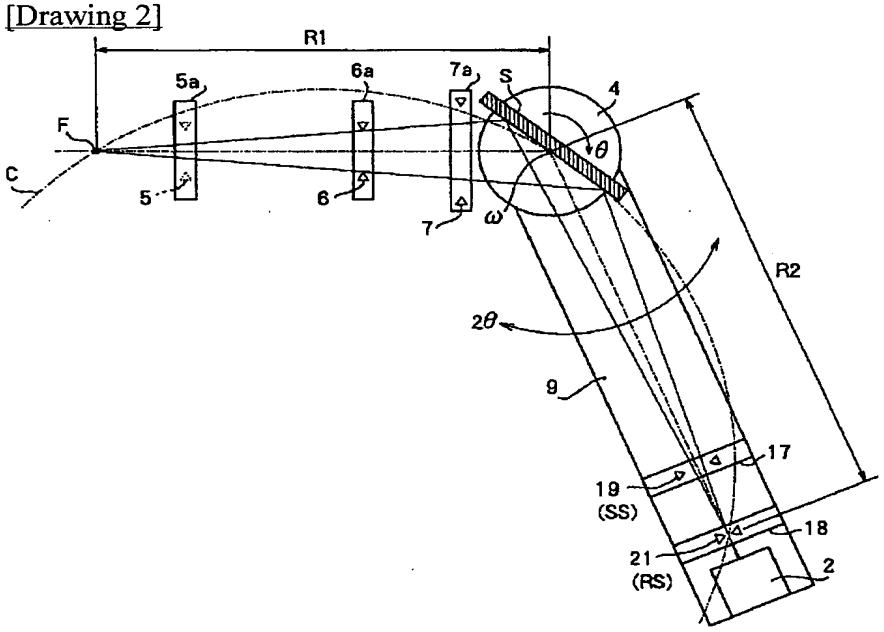
[Drawing 5]



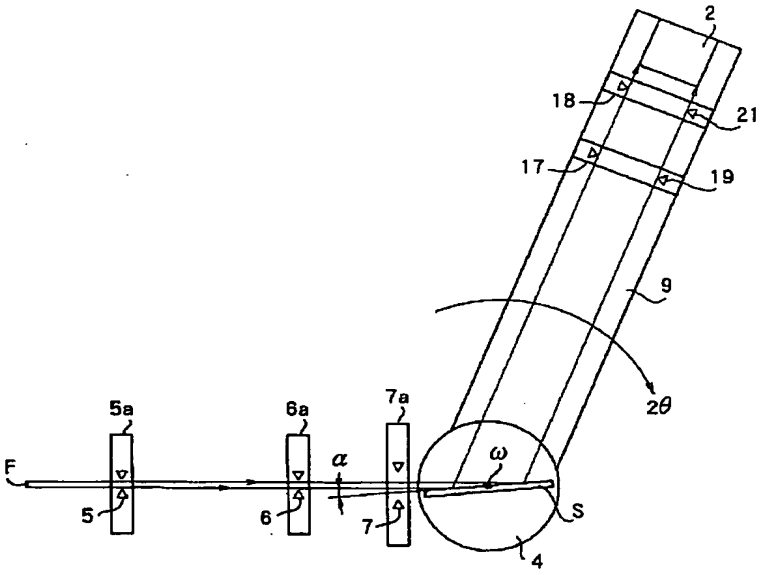
[Drawing 1]



[Drawing 2]



[Drawing 3]



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